

MIDDLETON. (W. D.) al

THE
GLUCOSE PRODUCT
AND
SUGGESTIONS AS TO ITS THERAPEUTIC
VALUE.

BY
W. D. MIDDLETON, M.D.

DAVENPORT, IOWA.

[REPRINT FROM TRANSACTIONS OF IOWA STATE MEDICAL SOCIETY, VOL. IV. 1885.]

presented by the author



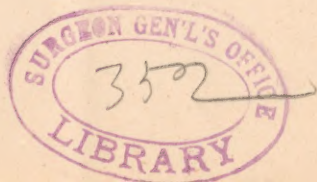
DAVENPORT, IOWA:
GLASS & HOOVER, PRINTERS AND BINDERS.
1885.

THE GLUCOSE PRODUCT, AND SUGGESTIONS AS TO ITS THERAPEUTIC VALUE.

I have no doubt that most of the members of this Society are conversant with the fact that we have three or four large establishments in our State employing a very large amount of capital in the manufacture of the substance known as glucose, or grape sugar, from our Indian corn. Many of you are also familiar with most of the details of the process employed, it being the simple manipulations of our school-day chemistry in which starch is treated with an acid; the magnitude of the operations and the financial element involved having only introduced much labor-saving apparatus, and so rendered financial success possible. The products of these factories are also probably familiar, either in the shape of the various fluids known as syrups of various names, or the white, tallow-like solid known in the market as "hard glucose." To many of you, innocent of any such familiarity of which you may be cognizant, the material has probably appeared under some other name, for it has been very largely used as an adulteration of both syrups and solid sugars.

It is scarcely, however, from a sugar-market point of view that we would ask you to consider the substance at a meeting of this kind, but simply to attempt to draw your attention to several conditions occurring in your practice in which, in the opinion of the writer, this material might, theoretically at least, render you marked assistance, with a view to perhaps enlisting some of you in a line of experiment whose results might be beneficial in the future.

To revert for a minute to these factories before spoken of: One encounters, first of all, a collection of immense vats, in



which shelled corn is being soaked, and from which an odor, partly sour and partly hinting of an incipient albuminous decay, makes itself slightly manifest. In these the grain is kept until it becomes softened and swollen by imbibition of water, when it is passed out, to be ground into something about as fine as our common corn meal, and made into a creamy fluid by the addition of water.

From the stones where it is ground it is passed over sifting-cloths in constant motion, and constantly acted upon by streams of water, until it is supposed that all the amylaceous particles of the grain have been washed through, and nothing of value remains in the debris—at least nothing of saccharine value.

In another portion of the establishment one finds the starch-house, in which, caught in long troughs, slightly inclined so as to cause a gentle current over the sediment, the material just seen to have escaped from under the sieves is depositing its starch in layers upon the bottom of these long receptacles. Many of you who have seen starch made from potatoes in bad years, when these tubers threatened to rot, would be reminded of the starchy sediment from that process, by this sediment in the starch department. Here a cruel waste of material comes to light, and constantly elicits careful study at the hands of those engaged in the manufacture—viz., the escape, at this point in the process, of fat and albumen. In a factory like that at Davenport, it is estimated that about five thousand pounds of fat and twelve thousand pounds of albumen are daily carried into the Mississippi by the gentle currents that pass along these starch-troughs from the upper to the lower end—a quantity of nutritive material certainly well worth the attention of experts in the manufacture.

Starch, gathered up in layers of different thickness, from the bottoms of these troughs, is carried to the converting-tubs, where the action of diluted sulphuric acid at a proper temperature is kept up upon the substance, to various degrees of completeness as regards sugar production. Where the production of syrup is desired, this action of acid is allowed to go on only

for a short time, in relation to complete conversion, and the fluid is removed from the converting-tub with only about fifty per cent of its starch changed to saccharine material, and the remainder left at the dextrine intermediate point, because of the danger of subsequent crystallization from the fluid if conversion is carried to greater limit. On the other hand, in manufacturing the solid product, the "hard glucose," the conversion is carried to a point where almost every particle of starch is changed, and the fluid readily crystallizes into the peculiar solid before spoken of, which, it is near enough truth to say, is absolutely pure glucose.

Subsequent to this conversion process comes a neutralization of the acid by the application of powdered carbonate of lime (marble dust); the evaporation to sufficient density, in immense vacuum-pans, at low temperature; the filtering and re-filtering, through animal charcoal and through "press" filters, in which linen fiber is enlisted in the eradication of impurities — and the product, solid or fluid, is complete, and ready for packing. It is, in short, our old, school-boy chemical experiment on an immense scale, with all the magnificent surroundings of steam and steam-driven machinery. The result has been, as with our experiment, and with the living tissue of plants glycogenic in nature, a hydration of starch.

This substance, with a chemical formula of $C_6H_{10}O_5$ — if the chemists know precisely how these organic compounds *are* made up — has undergone an addition of an equivalent of water, $H O$, and has become our liver friend, grape sugar, with a formula of $C_6H_{12}O_6$. It has gained slightly in weight, as one would suppose, from such addition, so that 99 parts of starch become 108 parts of sugar, or a gain of about nine per cent. Its taste, as represented in the syrups before mentioned, is far less sweet than that of cane syrups, for the reason before stated, that fifty per cent of the starch only has been completely converted, and the remainder arrested at the dextrine point. But even in the pure glucose this deficiency in sweetness is marked, and a peculiar element, difficult of

description, unless it be slightly bitter, and perhaps due to partial caramelization, appears in its impression upon the tongue. As a matter of fact, its sweetening power in comparison with cane sugar is as 2 to 3. Without doubt the most nutritious of the sugars, it seems singular that it has received so much abuse at the hands of the public, and that its open consumption has not reached greater limits, for, even making due allowance for its deficient sweetening power, it must be cheaper than the cane product, since it sells at about two and a half cents per pound.

The common newspaper objection to it, with which most of you have probably met in wise circles, that it will "turn tea black," you will readily understand to be due to the small amount of iron which it acquires in the evaporation process and in its various contacts with iron piping, the tannin of the tea infusion producing the change in color. It is generally ascribed to the imperfect removal from the substance of the acid with which the conversion is made, and the sad effects of "vitriol" upon the system are brought forward as a warning to all whose temerity may lead them to tamper with so dangerous a compound. *You* need hardly be told that this is a bugbear, for, to ascribe no higher object to the complete neutralization of the acid, the manufacturer has too much regard for his vast system of perishable piping and evaporation machinery to allow any trace of acid to remain in the fluids which must pass through them; and the neutralizing material is very cheap. In reality, the most probable cause, of the common disrespect for glucose, lies in the fact that its manufacturers have never attempted to impress upon it any individuality as a marketable food substance, but have been content to allow it to be thrown upon the market under any name but its own, until it has become known only as an adulterant, and has suffered in character thereby. Perhaps it will *always* be impossible to sell it as syrup without an admixture of cane syrup, on account of the great lack of sweetness in this half dextrine fluid we have before seen, which tastes like sweetened

mucilage; but certainly the solid product, fairly crystallized, might be safely sent into market upon its own merits, and would soon assert itself as a formidable rival of the cane derivative.

And now to the peculiar interest which we, as a profession, might find in the substance. At this point I must confess to feeling a little shamefaced, in having but one poor case in practice to bring forward as a reason for the faith that is in me, but you will remember that the object of the paper was to point out at present only a few theoretical indications.

I was called upon, over two years ago, by a young Davenport who had been working at his trade — blacksmith — in Missouri, during the summer preceding. Everybody, he said, had been suffering from “chills,” and he had had, from his description, a more than usually severe type of intermittent fever, which had finally yielded to medicines, but which had left him something of a wreck. You all know the type of patient — his face “saddle-colored;” his tongue pale; his spleen enlarged just enough so that one could call attention to the ague-cake prize he would shortly have drawn if he hadn’t changed climate; his liver protruding below the normal line, with its edge thickened; and his general make-up that of profound debility and anæmia. The only distress approaching pain, of which he complained, was in the region of the liver, and there he spoke of a constant sensation of weight and fullness, and of an occasional increase of that into positive pain, even.

I shall not attempt any refined pathology here; it is probably sufficient to say that if any one thing can be positively charged to malaria as a cause, it is the tendency to congestions of internal organs, and the liver is the largest of all. It is not necessary here to say how important its position is as the gateway of the portal group of vessels, nor why such congestion could readily impair all digestive functions, and so prolong anæmic conditions. Neither is it desirable to dwell upon its functions longer than simply to indicate stepping-stones in

a course of reasoning, as follows: Under the above conditions, the glycogenic function of the liver probably suffers extensively. We do not positively know what proportion of the glucose manufactured directly from starch in the process of digestion is *immediately* used in the bodily processes, and what proportion is stored up in the liver in the shape of glycogen, to be paid out as the wants of the body require; but we imagine that a large proportion goes in the latter direction, and that the liver's store-house or savings-bank action in this manner is very important. There is not a question in our minds about the great necessity for a constant supply of glucose to the tissues, and we notice the large size (proportional) of the liver in the foetus as an indication of the necessity of glucose in the early growth of the economy. Suppose the obstruction at the portal center, before hinted at; suppose the consequent impairment of amylaceous digestion; and further suppose the impairment of the glycogenic function by increased pressure in the liver itself — then the following seems a fair inference: Ingestion of glucose at short intervals during the day will render the digestion of starch comparatively unnecessary; it may also put the glycogenic operations of the liver temporarily in abeyance. If it accomplishes the latter purpose, then it will be eminently useful in this case, for it is the "rest and pain" idea, the splint idea, applied to the liver, which is the key to the position.

Whatever you think of the logic, this was the result: The young man, I found, was not averse to eating syrup — in fact, had always liked it. We procured a supply of the liquid glucose, and he was directed to eat it freely at meals, and, when he felt that he could (his stomach was rather capricious), to indulge between meals. He stated that he did not like the syrup as well as the common cane syrups — it is not palatable — and so his consumption of it was not rapid — between two and three quarts the first week; but the scales, that week, showed a positive increase of seven pounds in weight, or one pound a day. He increased in weight the second week about three pounds,

and less the third week; but his appearance improved wonderfully, his appetite and strength increased, and in a month, or thereabouts, he was able to work at that hard labor — horse-shoeing.

I give the case for what it is worth — saying only that I do not think it wrong to say, *post hoc ergo propter hoc*, in the light of some little experience with that kind of cases. I think he found the syrup a highly nutritious substance, and that we gave the liver a rest from its labors. In similar cases I hope to hear of some trials of the substance, by some of you, with a view to confirming theoretical deductions, if the theory happens to suit you.

Another place, theoretically, in which the syrup might be employed, of course, would be one where the digestion of starch was impaired from any cause. If we regarded the average starch consumption as in the neighborhood of ten ounces of pure starch, we can figure, as produced from that, about eleven ounces of pure glucose; and, although the objection constantly arises to one's mind that the palate may rebel against something so unnatural as the starch already changed, an amount of sugar so small as that would seem easy enough of consumption in small quantities frequently repeated. At least it seems reasonable to suppose that any pathological condition, temporarily present, which impaired amyloid digestion, might be "flanked," so to speak, by giving all the organs interested in such digestion a vacation for a short time, as we imagined we did in the case of the liver before mentioned.

Another opportunity for its use, one mentions with some considerable hesitation, is that furnished by some of the wasting diseases of children. Hesitation here arises from the fact that this is the most readily fermentible of all the sugars, and that, in many of these cases, fermentation of food seems at the base of the troubles. But, in defense of the attempt to supply a highly nutritious material like this, even at the risk of exciting fermentation in the alimentary canal, one might say that a substance like this, requiring of that alimentary

tract no digestion, but simply the physical process of absorption, promised rapid restoration and blood supply in about the same manner that it was promised by nutritive enemata, and was certainly worth a trial.

Further, we might add, with some misgiving, the conditions known as diabetes, as proper for a trial of food of this kind. I believe it is pretty generally conceded that *two* conditions are attended with an elimination of sugar by the urine — one in which the bodily standard is for a long time maintained at a fair position, and the other in which rapid emaciation and loss of strength are manifest. In the first it is supposed the *manufacture* of sugar by the liver is in excess of the quantity demanded by the tissues, and the elimination is simply a surplus; in the second, with only the natural amount furnished, the tissues are unable to assimilate the sugar, and it passes off. “Excessive formation,” we are told, marks the one; “defective assimilation” the other. In the variety attended with excessive formation of course there may be a great variety of causative conditions, and any part of the nervous circle from the liver to the brain, and back again, may be the seat of the irritation, determining hyper-secretion. But in instances where the irritation has its seat in the liver-cells themselves, as in cases where alcohol, passing in by the portal vein, has originated the difficulty, it would seem as if the administration of some such substance, allowing of a subsidence of the glycogenic work of the organ, might work benefit.

In the *other* variety of the disease, which is often so harmfully treated by dietetic regimen, where all tissues seem unable to assimilate this material, and where great quantities of water must be drunk and passed off in urine to dissolve it and wash it out of the economy, its use, of course, would seem like adding fuel to flame; but here, even, from its great nutritive value, a rational and carefully observed administration might be of benefit. There *must* be a place for it in diabetic cases, it seems to me — though here, I must confess, its claims are very weakly presented.

Not to drag this out any longer, it is the idea of the writer that this substance, now finding its way into our markets, will be useful to us in many cases of impaired nutrition—the limits of its usefulness lying within the lines we so often find circumscribing our attempts at restoring strength, of the ability of the digestive and assimilative mechanisms to properly appropriate it.

We have no end of constructives and nutritives of all sorts, which we give a fair field, and toward which we all lean kindly, from an asthenic idea of most of our diseases; and if we spend great amounts of money for various preparations of malt, whose only claim to our favor is that, by certain elements contained in them, such as diastase, or maltine, or what not, they accomplish, in impaired states of digestion, the change of starch into grape sugar, surely the sugar itself (always, of course, remembering the capriciousness of sick palates) might be fairly assumed to be a reasonable nutritive, and should be given a fair trial. It is ready to hand, is not unpalatable, can be procured at very cheap rates, and I hope many of you may feel inclined to experiment with it for our future information. It may have been made the subject of experiment before, but I have no knowledge of it, and, save the use of sugar candy—from cane sugar, of course—mentioned in Harley as having been tried in diabetes, I have no hint in that direction.

